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DATA OBSERVATIONS FOR 155 FLIGHT OF  
MSFC/ABMA RELATED AEROSPACE VEHICLES  
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SUMMARY OF ATMOSPHERIC DATA OBSERVATIONS  
FOR 155 FLIGHTS OF MSFC/ABMA RELATED  
AEROSPACE VEHICLES

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## TABLE OF CONTENTS

	Page
INTRODUCTION.....	1
BACKGROUND.....	1
PARAMETERS GIVEN.....	2
TABLE DISCUSSION.....	2
CONCLUSION .....	3
REFERENCES.....	14

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## LIST OF TABLES

Table	Title	Page
1.	<b>Selected Atmospheric Observations for 155 Flight Tests of the Redstone, Jupiter, Pershing, and Saturn Vehicles. . . . .</b>	<b>4</b>
2.	<b>Extreme Wind Components, Shear Values, and Density Deviations in the High Dynamic Pressure Region for Saturn I through Saturn 208 Vehicles . . . . .</b>	<b>10</b>
3.	<b>Launch Atmospheric Extremes at Ground Level and in the Max Q Region (8 to 16 km) for all Saturn and Pre-Saturn Vehicles . . . . .</b>	<b>13</b>

TECHNICAL MEMORANDUM X-64796

SUMMARY OF ATMOSPHERIC DATA OBSERVATIONS FOR  
155 FLIGHTS OF MSFC/ABMA RELATED  
AEROSPACE VEHICLES

INTRODUCTION

This report presents a summary of selected atmospheric conditions observed near launch time for 155 flights of the Redstone, Jupiter, Pershing and Saturn vehicles (Saturn I, IB, and V).

This document by no means lists atmospheric data taken during every major NASA sponsored launch. Only MSFC related type launches are listed here. Except as noted otherwise, all vehicles were launched from Cape Kennedy, Florida, during the period from August 20, 1953 through November 16, 1973. The atmospheric data for each vehicle launch were supplied by the appropriate range weather services collaborating with this organization. The observations were taken as near to the vehicle launch times and areas as possible, and are believed to be representative of the atmospheric conditions for each vehicle launch.

BACKGROUND

An initial Marshall Space Flight Center (MSFC) report [1] was published in 1960 which contained atmospheric data for 101 early launches of the Redstone, Jupiter and Pershing missiles. An internal MSFC office memorandum<sup>1</sup>, issued in 1967, gave weather information taken during the early Saturn I/IB launches. This report now consolidates these previously published documents and additionally gives the Saturn V atmospheric observations.

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1. NASA-MSFC memorandum R-AERO-YT-10-67, Summary of surface atmospheric data observations during previous Saturn vehicle launches, April 18, 1967.

NASA-MSFC memorandum R-AERO-YT-13-67, Selected atmospheric observations for thirteen Saturn I/IB vehicle launches, April 26, 1967.

## PARAMETERS GIVEN

Only certain atmospheric quantities are listed in the tables of this report. These listings were determined from the most frequently asked questions concerning launch atmospheric data.

Table 1 presents atmospheric pressure, temperature, relative humidity, and ground winds, along with maximum winds aloft in the maximum dynamic pressure region (max Q) from 8 to 16-km altitude. Cloud observations were added starting with the Saturn vehicle series. Also a column entitled "Comments" has been added that gives any weather information affecting launch or pre-launch activities. References 2 and 3 were used to help complete this comments column. Updating the vehicle launch information, i.e., vehicle number, date and time of launch, and the addition of launch pad numbers required the use of Reference 4<sup>2</sup>. There are a few Agena and Centaur launches not in the Table 1 listing, due to the unavailability of data to the author.

Table 2 gives extreme pitch and yaw wind components and shears, along with maximum density, in the high dynamic pressure region for the Saturn launch series (SA-1 through SA-208).

Given in Table 3 are all the extreme parameters for each type vehicle. The vehicles were broken down into Saturn I (SA-1 through SA-10), Saturn IB (AS-201 through SA-208), Saturn V (AS-501 through SA-513), and pre-Saturn which includes all previously launched non-Saturn type missiles.

## TABLE DISCUSSION

Based on these official records, the tables indicate that out of a total of 31 Saturn launches to date, only once has a Saturn vehicle been launched through rain (AS-507), twice through fog (SA-206 and 207), and three times (SA-1, AS-201 and AS-509) had weather conditions which caused either a countdown hold or a launch postponement.

Table 3 extremes indicate that no vehicle has been launched with ground winds greater than 10.7 m/s (SA-10). The greatest wind speed aloft encountered near max Q has been 88.0 m/s (Redstone CC-46). The Saturn V vehicle

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2. This includes an unpublished reference document compiled by William A. Lockyer, Jr. of KSC's Historical Services, entitled, "A chronological listing of launchings of MSFC-related vehicles from 1953-1972".

(AS-504) had encountered a maximum wind speed of 76.2 m/s near max Q altitude. AS-504 also encountered the most extreme pitch wind aloft (74.5 m/s), pitch wind shear<sup>3</sup> aloft ( $0.0248 \text{ sec}^{-1}$ ) and yaw wind shear<sup>3</sup> aloft ( $0.0254 \text{ sec}^{-1}$ ).

Atmospheric density has varied from -7.8 percent (Jupiter AM-28) to +6.3 percent (Jupiter AM-19) of the annual PRA-63 atmosphere [5] in the max Q region. These extreme densities encountered are close to the absolute Cape Kennedy density limits of -10.1 percent (at 14 km) and +8.4 percent (at 16 km) as given in [6].

The surface thermo-dynamic parameter extremes for all launches are as follows. Ambient pressures have varied from 10.014 to 10.330 N/cm<sup>2</sup>, temperatures from 6.7°C (44°F) to 32.2°C (90°F), and relative humidities have ranged from 24 to 100 percent.

## CONCLUSION

Obviously the tables presented in this report do not summarize all atmospheric records that were taken at launch times. If additional or more detailed atmospheric information is needed for any Saturn vehicle launch, the reader should refer to the NASA-Marshall, Saturn Flight Evaluation Working Group report [2] pertaining to the launch in question. Additionally, the Marshall, Aerospace Environment Division has issued a launch pad ground wind memorandum for each Saturn vehicle launch since SA-7. These are available upon request. The Terrestrial Environment Branch also maintains an atmospheric file containing the atmospheric data supporting most previous Marshall vehicle test flights.

This summary of atmospheric conditions at launch for the various vehicles is not meant to imply that this is the range of atmospheric conditions which may occur at the launch site. These were basically R and D type vehicles and an "operational" deployed vehicle might encounter a larger range (variation) of atmospheric conditions. It should be noted that the atmospheric conditions at launch for these vehicles were closely monitored during the prelaunch period. Adverse weather conditions were deliberately avoided based on trend indications, prediction of probably T-0 conditions and real time measurements.

3. Shears were computed over a 1000 meter interval.

TABLE 1. SELECTED ATMOSPHERIC OBSERVATIONS FOR 154 FLIGHT TESTS OF  
THE REDSTONE, JUPITER, PERSHING AND SATURN VEHICLES

VEHICLE DATA				SURFACE OBSERVATIONS					INFLIGHT CONDITIONS MAN. WIND IN 8-16 KM REGION				COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE
Seq. No.	Vehicle No.	Launch Date	Time <sup>a</sup> (EST) Nearest Minute	Launch Pad	Press N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)	Speed (m/sec)	Dir. (Deg.)	Alt. (km)	Speed (m/sec)	Dir. (Deg.)	
1	RS-1	20 Aug 53	0837	4	No record available	24.0	71	2.5	293	12	39	270	Hold for 113° min due to adverse weather
2	RS-2	27 Jan 54	1020	4	10.252	24.0							Hold for 106 min due to adverse weather
3	RS-3	5 May 54	1223	4	No record available								Hold for 45 min due to adverse weather
4	RS-4	18 Aug 54	0904	4	10.200	32.2	85	2.0	120	10	8	287	
5	RS-5	17 Nov 54	1312	4	10.110	26.0	89	4.0	180	12	29	310	
6	RS-6	9 Feb 55	1515	4	10.210	19.0	87	7.0	090	13	60	240	Hold for 44° min due to adverse weather
7	RS-8	20 Apr 55	0151	6	10.190	21.5	64	4.0	130	13	29	330	Hold for 221° min due to adverse weather
8	RS-10	24 May 55	2324	6	10.180	24.0	80	5.0	180	12	21	230	
9	RS-7	30 Aug 55	1911	6	10.119	27.0	79	4.0	113	12	15	250	
10	RS-11	22 Sep 55	0651	6	10.170	23.5	96	3.0	180	13	13	270	Hold for 140 min due to adverse weather
11	RS-12	5 Dec 55	1955	6	10.156	22.0	88	2.0	203	14	47	270	
12	RS-18	14 Mar 56	1836	6	10.190	23.0	85	7.5	140	13	41	310	
13	RS-19	15 May 56	2320	6	10.149	26.0	77	2.0	240	12	15	252	
14	CC-13	79 Jul 56	0948	6	10.186	22.2	95	1.0	225	12	25	130	Hold for 167 min due to adverse weather
15	RS-20	8 Aug 56	0326	6	10.137	25.0	82	0.5	200	12	8	80	
16	RS-27	20 Sep 56	0147	5	10.100	23.8	89	3.0	230	12	30	210	
17	CC-14	18 Oct 56	0406	6	10.146	17.8	96	1.5	225	11	39	210	
18	RS-25	30 Oct 56	2104	6	10.152	18.9	90	2.0	023	14	23	270	
19	CC-28	15 Nov 56	2106	6	10.210	17.8	70	3.5	045	14	20	290	
20	CC-15	29 Nov 56	0623	6	10.213	11.1	52	2.5	225	11	56	260	
21	CC-22	18 Dec 56	2229	6	10.251	20.6	93	2.5	225	12	27	300	
22	CC-16	18 Jan 57	2028	6	10.330	7.0	64	5.0	023	12	54	257	
23	AM-1A	1 Mar 57	1653	5	10.142	21.7	38	6.0	248	12	48	272	
24	CC-32	14 Mar 57	0312	6	10.149	20.0	87	2.5	158	12	39	250	
25	CC-30	27 Mar 57	2002	6	10.206	12.5	91	Calm	Calm	13	62	250	
26	AM-1B	26 Apr 57	1653	5	10.204	26.8	60	6.0	110	9	11	100	
27	RS-34	15 May 57	0255	6	10.136	21.1	92	Calm	Calm	15	23	280	
28	AM-1	31 May 57	1309	5	10.180	25.6	82	3.5	070	11	16	200	

TABLE 1. (Continued)

VEHICLE DATA				SURFACE OBSERVATIONS					INFLIGHT CONDITIONS MAX. WIND IN 8-16 KM REGION			COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE	
Seq. No.	Vehicle No.	Launch Date	Time <sup>8</sup> (EST) Nearest Minute	Launch Pad	Press. N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)	WIND <sup>a</sup> Speed (m/sec)	Dir. (Deg.)	Alt. (km)	Speed (m/sec)		Dir. (Deg.)
29	CC-31	26 Jun 57	0609	6	10.133	23.4	94	2.5	225	12	21	300	Hold for 429 min due to adverse weather Hold for 40 min due to adverse weather
30	CC-35	12 Jul 57	0130	6	10.146	23.3	100	Calm	Calm	12	16	280	
31	CC-37	25 Jul 57	2317	6	10.159	22.8	97	1.5	203	15	12	36	
32	RS-40	8 Aug 57	0159	5	10.180	23.8	93	1.0	140	11	14 <sup>⊙</sup>	290	
33	AM-2	28 Aug 57	1602	26B	10.173	26.7	88	3.0	068	9	13	110	Hold for 235 min due to adverse weather
34	CC-38	10 Sep 57	2141	6	10.210	26.7	91	3.0	090	13	11	40	
35	CC-39	2 Oct 57	1429	6	10.115	27.8	9	2.5	360	12	10	270	
36	AM-3	22 Oct 57	2007	26B	10.254	22.8	87	4.5	045	13	39	330	
37	CC-41	30 Oct 57	2353	6	10.163	17.2	85	2.5	315	12	36	272	
38	AM-3A	26 Nov 57	2101	26B	10.180	18.9	84	1.5	090	13	40	280	
39	CC-42	10 Dec 57	1836	6	10.142	8.3	58	3.5	248	12	35	270	
40	AM-4	18 Dec 57	1908	26B	10.183	17.8	90	2.5	360	12	52	300	
41	CC-15	14 Jan 58	2024	6	10.139	11.7	91	2.5	270	13	76	290	
42	RS-29	31 Jan 58	2248	26A	1.115	16.3	71	7.0	170	13	73	250	
43	CC-46	11 Feb 58	1954	6	10.090	15.1	93	2.0	310	12	88	250	
44	CC-43	27 Feb 58	1500	6	10.014	27.2	60	7.0	248	8	49	270	
45	RS-26	5 Mar 58	1328	26A	10.210	20.0	77	6.0	058	8	38	280	Hold for 235 min due to adverse weather
46	RS-24	26 Mar 58	1238	5	10.061	20.6	73	5.5	270	11	74	200	
47	RS-1002	16 May 58	1905	5	10.176	21.8	79	3.6	090	15	24	260	
48	AM-5	18 May 58	0005	26B	10.170	22.6	78	5.1	070	15	22	250	
49	CC-1004**	2 Jun 58	2150 MST	5	8.760**	28.0	24	5.1	180	14	25	260	
50	CC-48	11 Jun 58	2059	6	10.146	26.7	85	4.0	158	13	35	240	
51	CC-54	24 June 58	2236	6	10.183	23.3	96	3.5	180	12	14	220	
52	AM-6B	17 Jul 58	0404	26B	10.163	26.9	82	3.5	130	16	25	90	
53	RS-44	26 Jul 58	1003	5	10.170	28.4	83	2.6	190	16	20	90	
54	CC-50***	31 Jul 58	2347 LST	5	10.132***	26.7	75	7.5	070	12	13	258	
55	CC-51***	11 Aug 58	2327 LST	5	10.128***	26.6	79	9.0	070	14	9	262	
56	RS-47	24 Aug 58	0117	5	10.149	27.2	91	3.5	135	12	14	20	
57	AM-7	27 Aug 58	1815	26A	10.064	26.1	88	3.5	339	13	16	200	
58	CC-56	17 Sep 58	1300	6	10.176	30.6	55	4.5	113	14	9	23	
59	AM-9	9 Oct 58	2249	26B	10.168	22.8	81	2.0	090	16	10	140	
60	RS-49	22 Oct 58	2221	5	10.146	15.6	93	2.0	270	10	30	310	



TABLE 1. (Continued)

VEHICLE DATA				SURFACE OBSERVATIONS					INFIGHT CONDITIONS MAX. WIND IN 8-16 KM REGION			COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE	
Seq. No.	Vehicle No.	Launch Date	Time <sup>a</sup> (EST) Nearest Minute	Launch Pad	Press N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)	WIND <sup>a</sup>		Alt. (km)	Speed (m/sec)		Dir. (Deg.)
								Speed (m/sec)	Dir. (Deg.)				
61	CC-57	5 Nov 58	1943	6	10.146	21.7	91	3.0	360	12	33	270	Hold for 169* min due to adverse weather Adverse weather postponed launch
62	AM-11	6 Dec 58	0044	5	10.190	14.4	94	1.5	248	13	31	260	
63	AM-13	13 Dec 58	0358	26B	10.217	6.7	89	3.5	315	11	47	250	
64	CM-31	21 Jan 59	1910	5	10.166	20.6	93	7.5	158	16	34	230	
65	CM-32	27 Feb 59	0049	26B	10.146	17.8	97	2.0	360	13	52	250	
66	AM-14	4 Mar 59	0011	5	10.182	8.5	79	2.5	310	12	40	240	Adverse weather postponed launch
67	CM-32-A	3 Apr 59	1934	26B	10.125	20.3	73	2.5	200	13	44	270	
68	AM-12	6 May 59	2048	26B	10.213	22.0	88	4.0	110	12	33	360	Hold for 225 min due to adverse weather
69	AM-17	14 May 59	0052	5	10.155	22.1	90	3.5	220	12	37	260	
70	AM-18	26 May 59	0235	26B	10.183	23.9	83	5.5	090	13	18	240	
71	AM-16	9 Jul 59	2001	26B	10.187	25.5	87	3.0	293	14	8	26	
72	AM-16	16 Jul 59	1237	5	10.190	30.0	70	5.1	90	13	19	60	Hold for 54 min due to adverse weather
73	CC-3003	21 Jul 59	2202	26A	10.188	26.0	86	4.1	110	13	29	30	
74	CC-3004	4 Aug 59	2105	26A	10.142	25.6	84	4.8	112	12	29	70	
75	AM-19-B	14 Aug 59	1931	26B	10.186	24.9	95	2.1	90	13	19	350	
76	AM-19	26 Aug 59	2030	5	10.169	25.2	86	2.6	98	16	14	61	
77	AM-23	16 Sep 59	1945	26B	10.112	23.0	89	2.6	240	11	30	220	
78	AM-24	30 Sep 59	2028	6	10.116	24.4	93	2.6	112	11	13	180	
79	AM-19-A	13 Oct 59	1030	5	10.169	28.6	73	3.0	68	15	24	320	
80	CM-31	21 Oct 59	2220	26A	10.188	25.0	92	4.6	180	14	25	287	
81	CM-33	4 Nov 59	1938	6	10.190	21.9	86	3.1	112	11	10	280	
82	AM-25	18 Nov 59	2032	26B	10.162	20.0	82	7.8	68	13	34	253	
83	AM-32	9 Dec 59	1908	6	10.249	12.1	89	1.2	315	13	36	276	
84	AM-36	16 Dec 59	1903	26B	10.190	18.3	92	2.0	120	11	31	283	
85	AM-38	25 Jan 60	1948	26B	10.263	8.8	73	1.6	350	14	44	268	
86	AM-30	4 Feb 60	1919	6	10.142	19.3	86	2.1	90	9	55	238	
87	P-105	25 Feb 60	1302	30A	10.075	27.9	62	8.2	210	10	55	248	
88	CC-3020	21 Mar 60	2022	6	10.234	10.6	53	5.1	360	13	73	258	
89	AM-19-C	23 Mar 60	0835	26B	10.204	15.1	68	5.7	320	14	23	256	
90	P-106	20 Apr 60	1330	30A	10.196	25.9	67	4.6	110	14	24	266	
91	P-107	10 May 60	1100	30A	10.132	23.9	44	6.2	202	15	42	240	
92	P-108	9 Jun 60	1119	30A	10.122	27.8	74	5.7	45	14	16	263	
93	P-109	30 Jun 60	1100	30A	10.184	28.8	72	5.1	150	13	24	40	

TABLE 1. (Continued)

Seq. No.	VEHICLE DATA				SURFACE OBSERVATIONS				INFLIGHT CONDITIONS MAX. WIND IN 8-16 KM REGION				COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE
	Vehicle No.	Launch Date	Time <sup>g</sup> (EST) Nearest Minute	Launch Pad	Press. N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)	WIND <sup>a</sup> Speed (m/sec)	Dir. (Deg.)	Alt. (km)	Speed (m/sec)	Dir. (Deg.)	
94	P-110	26 Jul 60	1100	30A	10.163	28.7	70	1.5	120	14	18	38	Hold for 74 min due to adverse weather
95	CC-2023	9 Aug 60	2031	6	10.186	26.7	86	2.6	158	13	21	70	
96	P-205	28 Sep 60	1438	30A	10.105	28.1	75	7.7	170	13	23	285	
97	CC-2037	5 Oct 60	2344	6	10.180	26.7	70	6.7	110	12	26	522	
98	CM-217	19 Oct 60	1102	28A	10.146	29.2	65	10.0	230	15	27	274	
99	AM-19D	2 Nov 60	0023	28B	10.164	17.5	84	2.6	324	12	39	231	
100	P-206	16 Nov 60	1325	30A	10.176	26.5	68	3.1	150	13	16	338	
101	P-307	12 Dec 60	1342	30A	10.127	14.3	53	7.7	290	12	52	275	
102	MR-LA	19 Dec 60	1115	5	10.291	16.7	50	4.1	340	10	65	276	
103	P-306	5 Jan 61	1910	30A	10.228	15.4	66	2.6	340	12	47	277	
104	CC-2038	21 Jan 61	2104	6	10.220	6.8	54	7.2	285	14	66	261	Hold for 86 min due to weather evaluation
105	P-309	25 Jan 61	1930	30A	10.234	19.7	83	5.1	70	12	62	259	
106	MR-2	31 Jan 61	1155	5	10.284	20.0	50	4.6	80	13	60	310	
107	P-210	16 Feb 61	2027	30A	10.237	17.8	85	3.1	95	13	47	265	
108	AM-19F	24 Feb 61	1913	28B	10.150	22.0	86	8.2	170	12	35	288	
109	P-211	2 Mar 61	0037	30A	10.183	21.7	78	3.6	315	12	49	241	
110	CC-2040	8 Mar 61	2130	6	10.102	24.6	64	5.1	225	11	31	275	
111	P-212	16 Mar 61	2019	30A	10.134	15.8	73	1.5	170	12	44	288	
112	MR-BD	24 Mar 61	1230	5	10.144	22.1	49	6.2	10	13	68	247	
113	P-308	21 Apr 61	1053	30A	10.274	23.3	49	7.7	90	13	31	332	Adverse weather for 91 min. Postponed launch. Hold again for 41 min due to adverse weather
114	CM-209	22 Apr 61	0907	28A	10.268	22.9	58	3.6	90	14	39	342	
115	AM-19E	27 Apr 61	0917	28B	10.168	25.0	71	4.1	240	14	41	284	
116	MR-3	5 May 61	0934	5	10.225	27.0	67	4.6	90	15	31	292	
117	CC-2042	17 May 61	2100	6	10.174	25.1	84	3.6	50	11	31	275	
118	P-310	18 May 61	2100	30A	10.190	22.3	98	2.6	30	12	32	325	
119	AM-19G	24 May 61	1448	28B	10.165	22.3	65	5.1	40	13	54	275	
120	P-311	10 Jun 61	0011	30A	10.102	23.9	91	2.6	110	16	14	355	
121	CC-2043	26 Jun 61	2120	6	10.173	26.2	89	3.1	203	13	12	213	
122	P-312	30 Jun 61	2100	30A	10.195	25.0	91	1.0	200	11	19	219	
123	P-313	19 Jul 61	2100	30A	10.176	23.5	89	2.0	130	12	8	341	
124	MR-4	21 Jul 61	0720	5	10.185	28.5	81	2.9	190	14	13	62	

TABLE 1. (Continued)

VEHICLE DATA				SURFACE OBSERVATIONS				CLOUDS	INFLIGHT CONDITIONS MAX. WIND IN 8 TO 16 KM REGION			COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE		
Seq. No.	Vehicle No.	Launch Date	Time (EDT) Nearest Minute	Launch Complex	Press. N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)		Speed (m/sec)	Dir. (Deg.)	Alt. (m)		Speed (m/sec)	Dir. (Deg.)
125	SA-1	27 Oct 61	1006	34	10.224	26.2	64	6.4	85	8/10 cumulus	12.25	47.0	242	34 min hold at T-120 min, and 32 min hold at T-20 min due to low clouds over launch area affecting camera coverage. Project highwater conducted
126	SA-2	25 Apr 62	0901	34	10.205	24.6	59	3.5	180	1/10 stratocumulus, 3/10 cirrostratus	13.50	33.6	261	
127	SA-3	16 Nov 62	1245	34	10.193	23.9	48	4.0	250	2/10 cumulus, 4/10 cirrus	13.75	31.3	269	
128	SA-4	28 Mar 63	1512	34	10.176	23.9	71	6.0	40	1/10 cumulus, 1/10 stratocumulus	13.00	51.5	253	
129	SA-5	29 Jan 64	1125	37B	10.278	17.8	59	9.0	38	4/10 stratocumulus, 2/10 cirrus	10.75	42.1	268	
130	SA-6	28 May 64	1207	37B	10.142	28.9	64	5.0	150	1/10 cumulus, 1/10 cirrus	12.50	15.0	96	
131	SA-7	18 Sep 64	1123	37E	10.173	28.4	64	4.1	78	7/10 cumulus, 5/10 alto-cumulus, 1/10 cirrus	11.75	17.3	47	
132	SA-9	16 Feb 65	0937	37B	10.244	23.3	74	6.0	125	1/10 stratocumulus, 2/10 cirrus	13.00	34.3	243	
133	SA-8	25 May 65	0235	37B	10.186	22.8	83	4.4	143	1/10 cumulus, 3/10 cirrostratus	15.25	16.0	351	
134	SA-10	30 Jul 65	0900	37B	10.163	26.7	74	10.7	189	1/10 cumulonimbus, 2/10 alto-cumulus, 5/10 cirrus	14.75	15.0	306	
135	AS-201	26 Feb 66	1112	34	10.217	16.1	48	6.5	330	clear	13.75	70.0	250	Launch was postponed 3 times due to adverse weather conditions in recovery area
136	AS-203	5 Jul 66	0953	37B	10.166	30.2	69	6.3	242	1/10 cumulus, 1/10 alto-cumulus, 1/10 cirrus	13.00	18.0	312	
137	AS-202	25 Aug 66	1216	34	10.173	30.0	70	4.1	160	8/10 cumulus, 1/10 cirrus	12.00	16.0	231	
138	AS-201	9 Nov 67	0700	39A	10.261	17.6	55	8.2	070	4/10 stratocumulus	11.50	26.0	273	
139	AS-204	22 Jan 68	1748	37B	10.186	18.1	90	4.2	45	3/10 cumulus	12.00	35.0	288	
140	AS-202	4 Apr 68	0700	39A	12.200	20.9	83	5.4	132	5/10 stratocumulus, 1/10 cirrus	13.00	27.1	255	
141	AS-205	11 Oct 68	1103 EDT	34	10.180	28.3	65	10.2	90	3/10 cumulonimbus	14.60	15.6	309	
142	AS-203	21 Dec 68	0751	39A	10.207	15.0	58	5.7	348	4/10 cirrus	15.22	34.8	284	
143	AS-204	3 Mar 69	1100	39A	10.095	19.6	61	6.9	160	7/10 stratocumulus, 10/10 alto-cumulus	11.73	76.2	264	
144	AS-205	18 May 69	1249 EDT	39B	10.190	26.7	75	9.8	142	4/10 cumulus, 2/10 alto-cumulus, 10/10 cirrus	14.18	42.5	270	

TABLE 1. (Concluded)

VEHICLE DATA				SURFACE OBSERVATIONS				Clouds	INFLIGHT CONDITIONS MAX. WIND IN 6 TO 16 KM REGION		COUNT DOWN AND LAUNCH COMMENTS OF METEOROLOGICAL SIGNIFICANCE
Seq. No.	Vehicle No.	Launch Date	Time (EST)	Launch Complex	Press. N/cm <sup>2</sup>	Temp. (°C)	Rel. Hum. (%)		Alt. (m)	Speed (m/sec)	
145	AS-508	16 Jul 69	0932 EDT	38A	10.203	29.4	73	1/10 cumulus, 2/10 alto-cumulus, 9/10 cirro-stratus	11.40	9.6	297
146	AS-507	16 Nov 69	1132	38A	10.061	20.0	92	10/10 stratocumulus with rain	14.22	47.6	245
147	AS-508	11 Apr 70	1413	38A	10.119	24.4	87	4/10 alto-cumulus, 10/10 cirro-stratus	13.58	55.6	252
148	AS-506	31 Jan 71	1803	38A	10.102	21.7	86	7/10 cumulus	13.33	52.8	255
149	AS-510	28 Jul 71	0834 EDT	38A	10.186	29.8	68	2/-0 alto-cumulus	13.75	18.6	063
150	AS-511	16 Apr 72	1254	39A	10.183	31.2	44	2/10 cumulus	11.85	26.1	237
151	AS-512	7 Dec 72	0033	39A	10.201	21.1	93	2/10 stratocumulus, 5/10 cirrus	12.18	45.1	311
152	SA-513	14 May 73	1330 EDT	39A	10.171	30.0	53	3/10 cumulus	12.70	34.4	287
153	SA-306	25 May 73	0900 EDT	32B	10.106	26.1	85	3/10 stratocumulus, 6/10 alto-cumulus	13.39	42.0	286
154	SA-307	28 Jul 73	0711 EDT	32B	10.182	23.9	93	5/10 fractocumulus, 5/10 alto-cumulus, 1/10 cirrus	13.83	13.2	014
155	SA-308	18 Nov 73	0941 EST	32B	10.186	22.2	79	9/10 alto-cumulus, 5/10 cirrus	12.35	43.5	254

It is not known at what height above natural grade these pre-launch ground winds were recorded, or whether they are instantaneous or averaged values. Instantaneous readings from charts at T-0 (unless otherwise noted) from anemometers on launch pad light poles at the following levels: Pad 34 at 15.5 m (50.4 ft.), Pad 37B at 20.7 m (68.1 ft.), and Pad 39A and B at 19.3 m (63.0 ft.). Beginning with AS-509, wind measurements were required at the 161.5 m (530 ft.) level from anemometer charts on the LUT. These instantaneous LUT winds are given directly under the listed pad light pole winds. Heights of anemometers are above natural grade.

Only part of total bold was due to weather.

May be higher — missing wind data from 11.2 to 13.4 km.

White Sands Test.

Johnson Island Test.

Eastern Standard Time, unless otherwise noted.

Station elevation is 1316 m above mean sea level.

Pressure given for mean sea level.

Not instantaneous, but a one minute average about T-0.

TABLE 2. EXTREME WIND COMPONENTS, SHEAR VALUES, AND DENSITY DEVIATIONS  
IN THE HIGH DYNAMIC PRESSURE REGION FOR SATURN I THROUGH SATURN 207 VEHICLES

Vehicle	MAXIMUM WIND COMPONENTS				MAXIMUM SHEAR VALUES ( $\Delta h=1000m$ )				MAX NEGATIVE % DENSITY DEVIATIONS		MAX POSITIVE % DENSITY DEVIATIONS	
	Pitch Plane		Yaw Plane		Pitch Plane		Yaw Plane		Neg. Dev. From PRA63	Alt. km	Pos. Dev. From PRA63	Alt. km
	Pitch ( $W_x$ ) m/s (knots)	Alt. km (ft)	Yaw ( $W_y$ ) m/s (knots)	Alt. km (ft)	Shear ( $sec^{-1}$ )	Alt. km (ft)	Shear ( $sec^{-1}$ )	Alt. km (ft)				
SA-1	36.8 (71.5)	13.00 (42,600)	-29.2 (-55.8)	12.25 (40,200)	0.0145	14.75 (48,400)	0.0168	16.00 (52,500)	-2.2	14.70	+1.2	9.70
SA-2	31.8 (61.8)	13.50 (44,300)	-13.3 (-25.9)	12.25 (40,200)	0.0144	15.00 (49,200)	0.0083	16.00 (52,500)	-3.8	13.00	+0.9	8.50
SA-3	30.7 (59.7)	13.75 (45,100)	11.2 (21.8)	12.00 (39,400)	0.0105	14.00 (45,930)	0.0157	13.00 (42,650)	-0.6	8.00	+2.1	13.50
SA-4	46.2 (89.8)	13.00 (42,600)	-23.4 (-45.5)	13.00 (42,600)	0.0155	13.00 (42,600)	0.0144	11.00 (36,100)	-7	15.00	+1.9	9.40
SA-5	41.1 (79.9)	10.75 (35,300)	-11.5 (-22.4)	11.25 (36,900)	0.0162	17.00 (55,800)	0.0086	10.00 (32,800)	-1.8	13.50	+1.5	16.00
SA-6	-14.8 (-28.8)	12.50 (41,000)	12.2 (23.7)	17.00 (55,800)	0.0121	12.25 (40,200)	0.0113	12.50 (41,000)	-1.2	15.75	+0.8	12.75
SA-7	-11.1 (-21.6)	12.75 (41,800)	14.8 (28.8)	12.00 (39,400)	0.0076	14.25 (46,800)	0.0068	11.25 (36,900)	-0.7	8.50	+5.0	15.50
SA-9	27.5 (53.5)	10.75 (35,300)	-23.6 (-45.9)	13.25 (43,500)	0.0096	10.50 (34,500)	0.0184	10.75 (35,300)	-2.8	11.00	+3.5	16.00
SA-8	12.0 (23.3)	11.00 (36,100)	14.6 (28.4)	15.25 (50,000)	0.0065	10.00 (32,800)	0.0073	17.00 (55,800)	-0.4	16.00	+1.2	10.50
SA-10	12.9 (25.1)	14.75 (48,400)	10.8 (21.0)	15.45 (50,700)	0.0130	14.75 (48,400)	0.0090	15.00 (49,200)	-1.5	8.50	+1.2	13.50
AS-201	57.3 (111.4)	13.75 (45,100)	-43.3 (-84.2)	13.25 (43,500)	0.0206	16.00 (52,500)	0.0205	12.00 (39,400)	-5.0	14.50	+0.8	8.00

TABLE 2. (Continued)

Vehicle	MAXIMUM WIND COMPONENTS						MAXIMUM SHEAR VALUES ( $\Delta h=1000m$ )				MAX NEGATIVE % DENSITY DEVIATIONS		MAX POSITIVE % DENSITY DEVIATIONS	
	Pitch Plane		Yaw Plane		Pitch Plane		Yaw Plane		Pitch Plane		Neg. Dev. From PRA63	Alt. km	Pos. Dev. From PRA63	Alt. km
	Pitch ( $W_x$ ) m/s (knots)	Alt. km (ft)	Yaw ( $W_y$ ) m/s (knots)	Alt. km (ft)	Shear ( $sec^{-1}$ )	Alt. km (ft)	Shear ( $sec^{-1}$ )	Alt. km (ft)	Shear ( $sec^{-1}$ )	Alt. km (ft)				
AS-203	11.1 (21.6)	12.50 (41,000)	16.6 (32.3)	13.25 (43,500)	0.0104	14.75 (48,400)	0.0079	14.25 (46,800)			-1.2	8.00	+2.0	13.00
AS-202	10.7 (20.8)	12.50 (41,000)	-15.4 (-29.9)	10.25 (33,600)	0.0083	13.50 (44,300)	0.0054	13.25 (43,500)			-1.0	8.00	+2.6	14.90
AS-501	24.3 (47.2)	11.50 (37,700)	12.9 (25.1)	9.00 (29,500)	0.0066	10.00 (32,800)	0.0067	10.00 (32,800)			-4.3	12.50	NO POS. DEV.	
AS-204	32.7 (63.6)	15.25 (50,000)	20.6 (40.0)	12.00 (39,400)	0.0118	16.75 (55,000)	0.0116	14.00 (45,900)			-5.7	16.00	+1.0	8.00
AS-502	27.1 (52.7)	13.00 (42,650)	12.9 (25.1)	15.75 (51,700)	0.0125	14.90 (48,900)	0.0084	13.28 (43,500)			-1.7	16.00	+1.6	11.50
AS-205	15.8 (30.7)	12.08 (36,800)	15.7 (30.5)	15.78 (47,500)	0.0113	15.78 (48,100)	0.0085	15.25 (46,500)			-0.1	8.00	+1.3	10.75
AS-503	31.2 (60.6)	15.10 (49,500)	22.6 (43.9)	15.80 (51,800)	0.0103	16.00 (52,500)	0.0157	15.78 (51,800)			-0.7	8.00	+3.3	11.75
AS-504	74.5 (144.8)	11.70 (38,390)	21.7 (42.2)	11.43 (37,500)	0.0248	15.15 (49,700)	0.0254	14.68 (48,160)			-6.1	14.00	NO POS. DEV.	
AS-505	40.8 (79.3)	13.80 (45,280)	18.7 (36.3)	14.85 (48,720)	0.0203	15.30 (50,200)	0.0125	15.53 (50,750)			-1.0	8.00	+3.3	14.00
AS-506	7.6 (14.8)	11.18 (36,680)	7.1 (13.8)	12.05 (39,530)	0.0077	14.78 (48,490)	0.0056	10.30 (33,790)			-0.2	8.25	+4.4	14.25
AS-507	47.2 (91.7)	14.23 (46,670)	-19.5 (-37.9)	13.65 (44,780)	0.0183	14.25 (46,750)	0.0178	14.58 (47,820)			-7.6	15.75	+1.2	10.50

TABLE 2. (Concluded)

Vehicle	MAXIMUM WIND COMPONENTS						MAXIMUM SHEAR VALUES ( $\Delta h=1000m$ )				MAX NEGATIVE % DENSITY DEVIATIONS		MAX POSITIVE % DENSITY DEVIATIONS	
	Pitch Plane		Yaw Plane		Pitch Plane		Yaw Plane		Pitch Plane		Yaw Plane		Pitch Plane	
	Pitch ( $W_x$ ) m/s (knots)	Alt. km (ft)	Yaw ( $W_y$ ) m/s (knots)	Alt. km (ft)	Shear ( $\text{sec}^{-1}$ )	Alt. km (ft)	Shear ( $\text{sec}^{-1}$ )	Alt. km (ft)	Shear ( $\text{sec}^{-1}$ )	Alt. km (ft)	Neg. Dev. From PRA63	Alt. km	Pos. Dev. From PRA63	Alt. km
AS-508	55.6 (108.1)	13.58 (44,540)	15.0 (29.1)	12.98 (42,570)	0.0166	15.43 (50,610)	0.0178	13.98 (45,850)			-2.8	14.25	+0.5	16.00
AS-509	52.8 (102.6)	13.33 (43,720)	24.9 (48.5)	10.20 (33,460)	0.0201	13.33 (43,720)	0.0251	11.85 (38,880)			-5.0	14.25	NO POS. DEV.	
AS-510	-17.8 (-34.6)	13.73 (45,030)	7.3 (14.2)	13.43 (44,040)	0.0110	11.23 (36,830)	0.0071	14.43 (47,330)			NO NEG. DEV.		+4.2	14.00
AS-511	26.0 (50.5)	11.85 (38,880)	12.5 (24.2)	15.50 (50,850)	0.0095	13.65 (44,780)	0.0114	15.50 (50,850)			-0.8	9.00	+4.0	16.00
AS-512	34.8 (67.6)	12.18 (39,945)	29.1 (56.8)	11.35 (37,237)	0.0177	7.98 (26,164)	0.0148	10.65 (34,940)			NO NEG. DEV.		+1.7	13.00
SA-513	26.2 (50.9)	13.03 (42,732)	24.0 (48.3)	12.68 (41,584)	0.0139	14.05 (46,095)	0.0107	9.25 (30,347)			-2.1	14.50	+2.2	13.25
SA-206	27.9 (54.2)	14.93 (48,966)	36.3 (70.6)	13.35 (43,799)	0.0145	14.93 (48,966)	0.0141	14.38 (47,162)			-1.7	15.25	+0.8	14.00
SA-207	-11.7 (-22.7)	12.43 (40,764)	9.6 (18.6)	8.60 (28,215)	0.0063	10.15 (33,300)	0.0083	15.50 (50,852)			-0.6	9.75	+4.3	14.75
SA-208	41.1 (77.8)	12.20 (40,026)	17.3 (33.6)	12.65 (41,502)	0.0131	11.50 (37,729)	0.0078	13.53 (44,373)			-1.5	13.75	+0.5	15.75

TABLE 3. LAUNCH ATMOSPHERIC EXTREMES AT GROUND LEVEL AND IN THE MAX Q REGION  
(8 TO 16 KM) FOR ALL SATURN AND PRE-SATURN VEHICLES

NASA Series	SEA LEVEL PRESSURE		SURFACE TEMPERATURE		SURFACE WIND SPEED	
	Min. 2 n/cm <sup>2</sup>	Max. 2 n/cm <sup>2</sup>	Min. 2 veh.	Max. 2 veh.	Min. 2 m/s	Max. 2 veh.
Pre-Sat.	10.014	CC-43	10.330	CC-16	6.7	AM-13
Saturn	10.142	SA-6	10.278	SA-5	17.8	SA-5
Sat. IB	10.105	SA-206	17.217	AS-201	16.1	AS-201*
Sat. V	10.081	AS-507	10.261	AS-501	15.0	AS-503
					31.2	AS-511
					3.3	AS-506
					9.8	AS-505

NASA Series	WIND SPEED ALOFT		PITCH WIND ALOFT		YAW WIND ALOFT	
	Max. m/s	Alt. km	Max. m/s	Alt. km	Max. m/s	Alt. km
Pre-Sat.	88.0	12.00	CC-46	(No Information Available)	(No Information Available)	(No Information Available)
Saturn	51.8	13.00	SA-4	46.2	13.00	SA-4
Sat. IB	70.0	13.75	AS-201	57.3	13.75	AS-201
Sat. V	76.2	11.75	AS-504	74.5	11.70	AS-504
					29.2	11.35
					11.35	AS-512

NASA Series	PITCH WIND SHEAR ALOFT **		YAW WIND SHEAR ALOFT **		EXTREME Z DENSITY DEVIATIONS ALOFT FROM PMA-63 #	
	Max. sec.	Alt. km	Max. sec.	Alt. km	Max. Dev. %	Alt. km
Pre-Sat.	.0162	17.00	SA-5	(No Information Available)	-7.8	14.00
Saturn	.0206	16.00	AF-201	.0184	10.75	SA-9
Sat. IB	.0248	15.15	AS-504	.0205	12.00	AS-201
Sat. V				.0254	14.68	AS-504
					-7.6	15.75
					4.3	AS-507
					4.4	AS-506

# density data was available for only 21 of 124 pre-Saturn launches.

\* AS-204, also.

\*\* shears were computed over a 1000 m interval.



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## APPROVAL

### SUMMARY OF ATMOSPHERIC DATA OBSERVATIONS FOR 155 FLIGHTS OF MSFC/ABMA RELATED AEROSPACE VEHICLES

By D. L. Johnson

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

  
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